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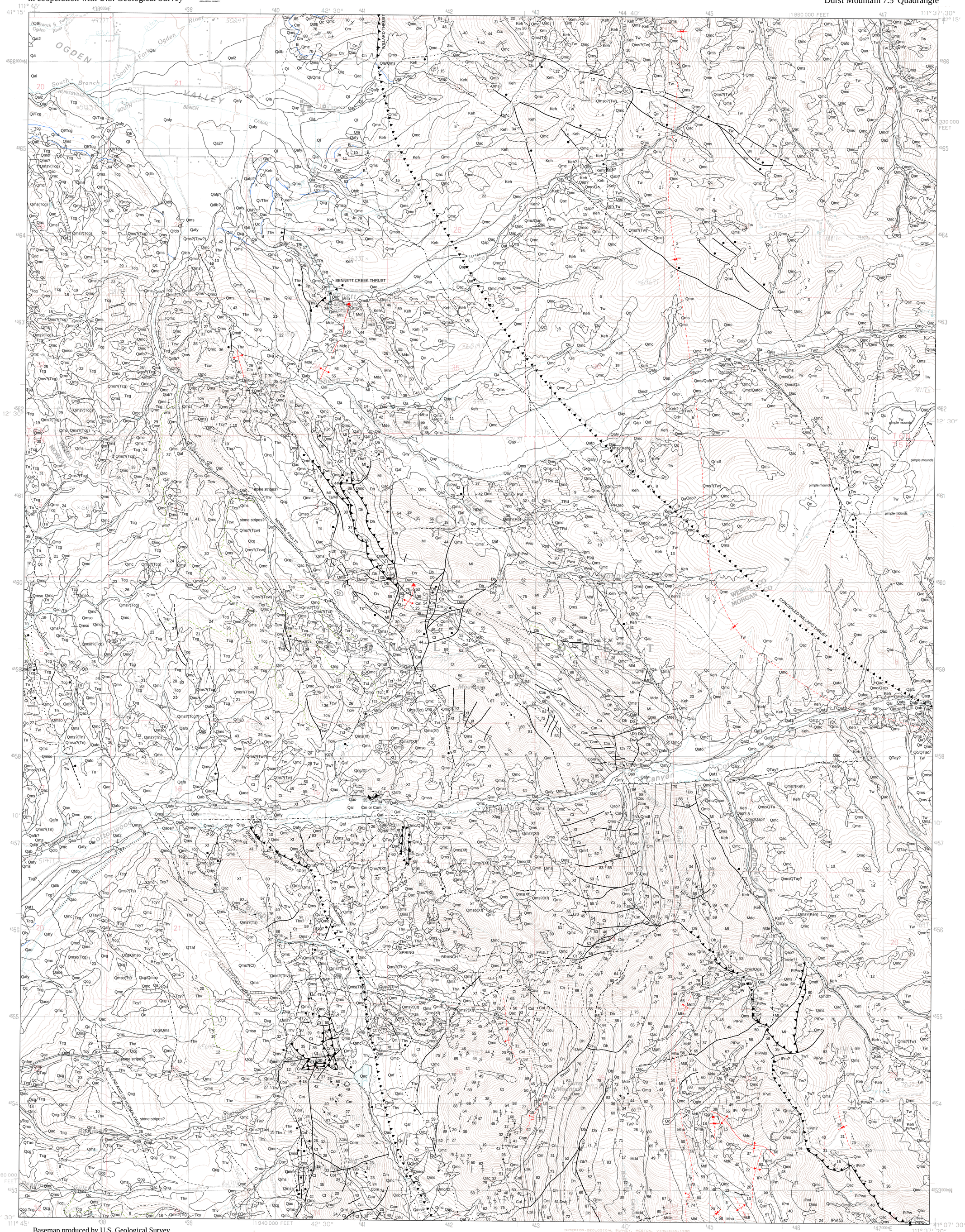
Open-File Report 498
Interim Geologic Map of the
Durst Mountain 7.5' Quadrangle



Basemap produced by U.S. Geological Survey

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NORTH

SCALE 1:24 000

1 .5 0 1 2 KILOMETERS
1000 0 1000 2000 METERS
.5 0 1 MILES
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 FEET

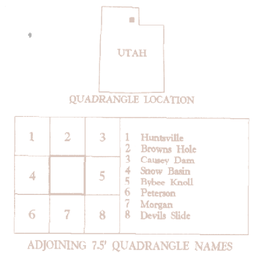
CONTOUR INTERVAL 40 FEET
To convert feet to meters multiply by .3048

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check.

INTERIM GEOLOGIC MAP OF THE DURST MOUNTAIN QUADRANGLE, MORGAN AND WEBER COUNTIES, UTAH

by JAMES C. COOGAN AND JON K. KING

2006



ROAD LEGEND

Improved Road
Unimproved Road
Trail
Interstate Route U.S. Route State Route

DURST MOUNTAIN, UTAH
PROVISIONAL EDITION 1990

41111-B6-TF-024

INTERIOR-GEOLOGICAL SURVEY, RESTON, VIRGINIA-1990

Interim Geologic Map of the Durst Mountain Quadrangle, Morgan and Weber Counties, Utah

by

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OPEN-FILE REPORT 498
UTAH GEOLOGICAL SURVEY
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SUMMARY

The Durst Mountain quadrangle is located east of Ogden, Utah (figure 1). The major geographic features in and near the quadrangle are Ogden and Morgan Valleys, the northern Wasatch Range to the west, the Ogden River and its forks in Ogden Valley, the Weber River in Morgan Valley, and Cottonwood Canyon, cut by Cottonwood Creek, separating Elk Mountain from Durst Mountain. Ogden and Morgan Valleys formed due to Cenozoic extensional faulting along at least one margin of each valley, and the valleys are filled with probable Oligocene Norwood Formation tuffaceous, lacustrine, and fluvial sedimentary rocks. The Precambrian (lower Proterozoic) Farmington Canyon crystalline rock complex and unconformably overlying Paleozoic (Cambrian through Permian) marine sedimentary strata are exposed on Durst and Elk Mountains. Mesozoic (Triassic and Jurassic) rocks are exposed northeast of Elk Mountain. A southern edge of the Willard thrust sheet, a Cretaceous structural feature containing late Proterozoic meta-sedimentary and Paleozoic sedimentary strata, is exposed in the northern part of the quadrangle and to the west in the Wasatch Range. The thrust sheet is likely buried under several thousand feet of Cenozoic valley fill in the northeast part of the quadrangle. The Cretaceous Ogden roof thrust is exposed to the west in the Wasatch Range and on Durst Mountain; its trace between exposures is likely present beneath the Cenozoic valley fill in the quadrangle. This roof thrust is east-directed and, due to rotation of the Durst-Elk Mountain block, is now east dipping. The Paleozoic and Mesozoic strata are in an east-dipping homocline that is locally complicated by Cretaceous folding, east- and west-directed thrusts and other faults, and is cut by Cenozoic extensional faulting. On the east flank of the Durst-Elk Mountain block, the latest Cretaceous Evanston Formation unconformably overlies the Precambrian, Paleozoic, and Mesozoic rocks, and these rocks and the Cretaceous thrust sheets are unconformably overlain by the Cenozoic (Eocene) Wasatch Formation. The Norwood Formation overlies the Wasatch Formation to the south in Morgan Valley and is overlain by and intertongues with unnamed conglomeratic strata on the west sides of Durst Mountain and Elk Mountain. These conglomeratic strata are unconformably overlain by still younger conglomeratic rocks of Miocene and/or Pliocene age. Remnants of Pliocene and/or Pleistocene alluvial deposits are present on both sides of Morgan Valley and along Cottonwood Creek. Quaternary (upper and possibly middle Pleistocene) glacial deposits cover bedrock locally east of Durst Mountain, and Quaternary (uppermost Pleistocene) lacustrine, deltaic, and alluvial deposits related to Lake Bonneville are present in Ogden and Morgan Valleys. Possible Quaternary fault scarps in this quadrangle are on mass movements of uncertain age on the west side of Durst Mountain, and on middle or lower Pleistocene alluvial deposits (>730 ka) north of Cottonwood Creek. Extensions of the fault in alluvium do not cut younger deposits, though changes in slope are present in Tertiary bedrock. All these scarps are part of the 10-mile (16-km) long fault system that bounds the west side of the Durst-Elk Mountain block, extending south to Morgan. South of the quadrangle near Morgan, Quaternary deposits are likely cut by extensional faults along the west side of Durst Mountain, but no scarps are visible.

Coogan mapped pre-Cenozoic rocks in the quadrangle, mostly on Elk and Durst Mountains. King is responsible for the Cenozoic rocks and deposits to the east and west of the mountains. Due to land access constraints, most of the map east of the Elk Mountain-Durst Mountain block is from interpretation of aerial photographs.

MAP UNIT DESCRIPTIONS

QUATERNARY

Qa, Qa2, Qay, Qap, Qab, Qao

Alluvium, undivided (Holocene and Pleistocene) - Sand, silt, clay, and gravel in stream and alluvial-fan deposits; composition depends on source area; distinguished from terraces (Qat) based on upper surface sloping toward adjacent drainage like an alluvial fan; relative ages are indicated by number and letter suffixes; Qa with no suffix used where age uncertain or age divisions of alluvium cannot be shown at map scale; generally 0 to 20 feet (0-6 m) thick, but Qap up to 50 feet (15 m) thick. Near latest Pleistocene Lake Bonneville, alluvium labeled y and 2 is younger than Lake Bonneville, mostly Holocene in age. Alluvium labeled Qap and Qab are graded to the Provo (and slightly lower) and Bonneville shorelines of Lake Bonneville (at ~ 4820 feet [1470 m] and 5180 feet [1580 m] in area), respectively; here letter o suffix means alluvium is older than Lake Bonneville. Elsewhere relative ages may only apply to local drainages. In the Durst Mountain quadrangle, ages of alluvium, including terraces and fans, are in part based on heights above present drainages (table 1); here Qay is at to slightly above, Qa2 is about 15 feet (5 m) above, Qap is 15 to 40 feet (5-12 m) above, Qab is 40 to 80 feet (12-24 m) above, and Qao is 70 to 120 feet (20-37 m) above present drainages. A prominent surface ("bench") is present on Qap at about 4900 feet (1495 m) in Morgan Valley (Snow Basin, Durst Mountain, Morgan, and Peterson quadrangles), and is about 25 to 40 feet (8-12 m) above the Weber River.

Qaoe Pleistocene alluvium (middle and lower Pleistocene) - Eroded alluvium located above the Bonneville shoreline and apparently above and older than pre-Lake Bonneville older alluvium (Qao and Qafo); mapped on benches about 80 to 100 feet (24-30 m) above Cottonwood Creek (higher than adjacent Qafo, but with height above drainage similar to Qao and Qafo) (table 1), and might be slightly older generation of older alluvium; also mapped on benches about 120 to 215 feet (35-65 m) above the Weber River in Morgan Valley at an elevation of about 5300 to 5350 feet (1615-1630 m); contains mostly sand, silt, and gravel in stream and alluvial-fan deposits; about 10 feet (3 m) thick; west of the Weber River in the Morgan quadrangle, dated by Sullivan and others (1988) as older than 730 ka, based on reversed paleomagnetism.

Qal, Qal2

Stream alluvium and flood-plain deposits (Holocene) - Sand, silt, clay, and gravel in

channels, flood plains, and terraces less than 10 feet (3 m) above stream level; locally includes muddy, organic overbank and oxbow lake deposits; composition depends on source area; 0 to 20 feet (0-6 m) thick; suffix 2 indicates slightly older deposits in Ogden Valley and near head of Cottonwood Canyon, with Qal2 including low terraces and being slightly (5 to 10 feet [1-3 m]) higher stream alluvium.

Qat, Qat2, Qatp, Qato

Stream-terrace deposits (Holocene and Pleistocene) - Sand, silt, clay, and gravel in terraces above flood plains, mostly along the Weber and South Fork of Ogden Rivers and Cottonwood Creek; number and letter suffixes indicate relative ages, with 2 being the youngest terraces; Qat with no suffix used where age uncertain or age divisions of terraces cannot be shown at map scale; 0 to at least 20 feet (0-6+ m) thick. Near latest Pleistocene Lake Bonneville, deposits with suffix 2 are younger than Lake Bonneville, and mostly Holocene in age, and deposits with o suffix are older than Lake Bonneville; elsewhere relative-age numbers and letters may only apply to local drainages. Terraces labeled Qatp are graded to the Provo and slightly lower shorelines of Lake Bonneville (at and < ~ 4820 feet [1470 m] in area), and with Qap form a "bench" at about 4900 feet (1494 m) along the Weber River in Morgan Valley. In the Durst Mountain quadrangle, terrace ages are partly based on heights above present drainages, with Qat2 about 20 feet (6 m) above, Qatp 25 to 30 feet (8-9 m) above, and Qato about 100 feet (30 m) above present drainages.

Qaf Alluvial-fan deposits, undivided (Holocene and Pleistocene) - Mostly sand, silt, and gravel that is poorly bedded and poorly sorted; includes debris flows, particularly in drainages and at drainage mouths (fan heads); generally less than 60 feet (18 m) thick. Mapped where fan age uncertain or for composite fans where portions of fans with multiple ages cannot be shown at map scale.

Qaf1, Qafy,

Younger alluvial-fan deposits (Holocene and uppermost Pleistocene) - Mostly sand, silt, and gravel that is poorly bedded and poorly sorted; includes debris flows, particularly in drainages and at drainage mouths (fan heads); generally less than 40 feet (12 m) thick. Near latest Pleistocene Lake Bonneville, deposits with suffixes 1 and y are younger than Lake Bonneville (mostly Holocene). Qaf1 are active and are on Qat2 terraces along east Cottonwood Creek in the Durst Mountains quadrangle; Qafy fans are active, impinge on present-day drainages and may be partly older than Qaf1 fans.

Qafp, Qafb, Qafo

Older alluvial-fan deposits (upper and middle(?) Pleistocene) - Incised fans of mostly sand, silt, and gravel that is poorly bedded and poorly sorted; includes debris flows, particularly in drainages and at drainage mouths (fan heads); generally less than 60 feet (18 m) thick. Fans labeled Qafp and Qafb are graded to the Provo (and slightly lower) and Bonneville shorelines of latest Pleistocene Lake Bonneville, respectively. Near Lake

Bonneville, unit Qafo is older than (above and apparently cut by) the Bonneville shoreline; upstream unit Qafo is above fans graded to the Bonneville shoreline. Elsewhere relative-age numbers and letters may only apply to local drainages. Like Qa and Qat suffixes, ages in the Durst Mountain quadrangle are partly based on heights above present drainages, in this case at drainage-eroded edge of fan, with Qafp about 40 to 45 feet (12-14 m) above, Qafb more than about 40 feet (>12 m) above, and Qafo about 70 to 110 feet (20-35 m) above present drainages. Dates presented in Sullivan and Nelson (1992) imply Qafo north of Morgan considerably predates Lake Bonneville and is middle Pleistocene in age (300-600 ka); however, the Bonneville shoreline is obscure on this fan.

Qafoe Eroded old alluvial-fan deposits (middle and lower Pleistocene) - Eroded fans located above and apparently older than pre-Lake Bonneville older alluvial-fan deposits (Qafo) along Cottonwood Creek; upper surface is about 160 feet (50 m) above eastern Cottonwood Creek and about 120 to 200 feet (35-60 m) above present streams in Morgan Valley; contains mostly sand, silt, and gravel that is poorly bedded and poorly sorted; less bouldery and lower relative to QTay, QTao, and QTaf; 0 to 60 feet or more (0-18+ m) thick; likely same age as Qaoe (>730 ka).

Qac Alluvium and colluvium (Holocene and Pleistocene) - Includes stream and fan alluvium, colluvium, and, locally, mass-movement deposits; 0 to 20 feet (0-6 m) thick.

Qc Colluvium (Holocene and Pleistocene) - Includes material moved by slopewash and soil creep; composition depends on local sources; generally 6 to 20 feet (2-6 m) thick; not mapped where less than 6 feet (2 m) thick.

Qcg Gravelly colluvial deposits (Holocene and Pleistocene) - Present downslope from gravel-rich deposits of various ages (for example, units Keh, Thv, QTaf, QTay/QTao, Qafoe/Qaoe, Qafo/Qao) but mostly mapped downslope from Thv on west side of Durst and Elk Mountains; typically differentiated from colluvium and residual gravel (Qc, Qng) by prominent stripes trending downhill on aerial photographs; stripes are concentrations of gravel up to boulder size; generally 6 to 20 feet (2-6 m) thick; some deposits previously included in Huntsville fanglomerate (see Thv).

Qng Colluvial and residual gravel deposits (Holocene and Pleistocene) - Gravel of uncertain origin, but probably mostly colluvium and residuum; poorly sorted pebble to boulder gravel in a matrix of silt and sand; typically dark colored, but this may be function of Thv source; mostly gravel-armored, nearly flat surfaces on bedrock but also includes steep area north of Cottonwood Canyon in Durst Mountain quadrangle; generally 6 to 20 feet (2-6 m) thick; previously included in Huntsville fanglomerate (see Thv) and mostly present on unit Thv.

Qmc Mass-movement and colluvial deposits, undivided (Holocene and Pleistocene) - Mapped

where landslides and slumps are difficult to distinguish from colluvium (slopewash and soil creep) and where mapping separate, small, intermingled areas of mass-movement and colluvial deposits is not possible at map scale; locally includes talus and debris flows; typically mapped where landslides and slumps are thin ("shallow"); also mapped where the blocky or rumpled morphology of the older (likely Pleistocene) mass movements has been diminished ("smoothed") by slopewash and soil creep; composition depends on local sources; 0 to 40 feet (0-12 m) thick.

Qms, Qms1, Qmsy, Qmso
: Landslide and slump deposits (Holocene and Pleistocene) - Poorly sorted clay- to boulder-sized material; locally includes flow deposits; generally characterized by hummocky topography, main and internal scarps, and chaotic bedding in displaced blocks; composition depends on local sources; morphology becomes more subdued with time; thickness highly variable. Qms without suffix is mapped where age uncertain (though likely Holocene and/or upper Pleistocene), where portions of slide/slump complexes of different ages cannot be shown separately at map scale, or where boundaries between slides/slumps of different ages are not distinct. Qms may be in contact with Qms when two different slide/slumps abut. Locally, unit involved in slide/slump is shown in parentheses where a nearly intact block is visible. Near latest Pleistocene Lake Bonneville, estimated time of emplacement indicated by relative-age number and letter suffixes, with: (1) emplaced in the last 80 to 150 years, historical; (y) post- Lake Bonneville in age, and mostly pre-historic; and (o) likely emplaced before Lake Bonneville transgression. On west margin of quadrangle, Qmso(Ts) block was emplaced before Qao, making it middle Pleistocene (see table 1). Suffixes y (as well as 1) and o indicate probable Holocene and Pleistocene ages, respectively. Contacts are present between separate slides/slumps/flows. Qms and Qmso queried where bedrock block may be in place. Qmso mapped where rumpled morphology typical of mass movements has been diminished and/or younger surficial deposits cover or cut Qmso.

Qmdf
: Debris-flow deposits (Holocene and upper Pleistocene) - Mostly sand, silt, clay, gravel, and cobbles in debris flows; deposits have lobate debris accumulations and others are in narrow drainages; some lack vegetation cover; 0 to 40 feet (0-12 m) thick

Qmrf
: Rock fall (Holocene and Pleistocene) - Angular, boulder-sized, Tintic Quartzite debris at base of cliffs south of Cottonwood Canyon (section 13, T. 5N., R. 2E.) (likely Holocene) and up Brushy Canyon (section 26, T. 5N., R. 2E.) (likely Pleistocene) in Durst Mountain quadrangle; estimate 0 to 20 feet (0-6 m) thick.

Qmt
: Talus (Holocene and Pleistocene) - Angular debris at the base of and on steep slopes; only larger debris fields can be shown at map scale, and include colluvium locally; mapped on southwest border of quadrangle and on Durst and Elk Mountains; likely less than 20 feet (6 m) thick.

Qmg Mass-movement and glacial deposits, undivided (Holocene and Pleistocene) - Deposits with hummocky topography in two cirques on Durst Mountain; southern landslide began in shaley bedrock and continued downslope involving glacial deposits; up to about 30 feet thick (<9 m); younger than Pinedale age (<15,000 yrs old).

Qg, Qgm, Qga

Glacial till and outwash (upper and middle? Pleistocene) - Qg is undivided glacial deposits; till is the material in a moraine (Qgm) and is non-stratified, poorly sorted clay, silt, sand and gravel, to boulder size; outwash (Qga) is better sorted and bedded due to alluvial reworking, is directly downslope from other glacial deposits, and is thick enough to obscure older deposits and bedrock; locally include mass-movements too small to show at map scale; 0 to about 100 feet (0-30 m) thick; likely Pinedale-age (~15,000 to 30,000 yrs old) deposits with poorly developed soil and moderate to sharp moraine morphology. Unlike in the Wasatch Mountains to the west, no sign of younger glacial deposits upslope, either as recessional deposits (about 13,000 to 14,000 years old) or in either cirque (about 8,000 to 10,000 years old) (see Madsen and Currey, 1979). Queried glacial deposits (Qg?) may be older (likely Bull Lake age, ~130,000 to 150,000 years old), and have well-developed soil; deposits on the northeast flank of Durst Mountain have subdued moraine morphology; in contrast queried deposits on northwest flank of Durst Mountain lack moraine morphology, but also lack an alluvial or mass movement source. Other possible glacial features are pimple mounds on Herd Mountain on the east margin of the quadrangle and possible stone stripes (solifluction) in unit Qcg.

Qla Lake Bonneville and post- and pre-Lake Bonneville alluvial deposits, undivided (Holocene and uppermost Pleistocene) - Mostly poorly sorted and poorly bedded sand, silt, and clay with some gravel; mapped near Bonneville shoreline (~5180 feet [1580 m] in area); stream alluvium has been deposited on lacustrine deposits in Ogden Valley rather than thin lacustrine deposits over alluvium; thickness uncertain.

Ql Lake Bonneville deposits, undivided (uppermost Pleistocene) - Includes cobbly gravel, sand, silt, and clay in Ogden Valley in Durst Mountain quadrangle; mapped where grain size is mixed or indistinct and deposits are not exposed in scarps or construction cuts; thickness uncertain.

Qls Lake Bonneville sand (uppermost Pleistocene) - Mostly sand with some silt and gravel deposited nearshore; typically less than 20 feet (6 m) thick where exposed to west near Mountain Green in Morgan Valley.

Qlg Lake Bonneville gravel (uppermost Pleistocene) - Mostly interbedded gravel and sand deposited along beaches and slightly offshore as the lake was near and at the Bonneville shoreline in Ogden Valley; likely less than 20 feet (6 m) thick.

Qdlb Lake Bonneville delta and lacustrine deposits, undivided (uppermost Pleistocene) -

Mostly sand, silty sand, gravelly sand, and cobbles deposited near shore as the lake transgressed to and was at the Bonneville shoreline; mapped where poor exposures preclude separation; mapped near the Bonneville shoreline in Ogden Valley (South Fork Ogden River and Bally Watts Creek) and along Cottonwood Creek; zero to at least 40 feet (0-12+ m) thick.

Qfdb Lake Bonneville alluvial-fan and delta deposits, undivided - Cobbly gravel, sand, silt, and clay deposited above (subaerially) and in Lake Bonneville (subaqueous) as lake transgressed to and was at the Bonneville shoreline; mapped where Bonneville shoreline obscure so that line cannot be drawn between delta and fan; typically should be better sorted delta and lake deposits over poorly sorted alluvial-fan deposits; 0 to at least 40 feet (0-12+ m) thick. Prominent along Bally Watts Creek; also present in Quarry Hollow and along Cottonwood Creek upstream from Qdlb.

Qh Human disturbance (Historical) - Obscures original deposits by cover or removal; borrow pit on farm in Ogden Valley. Also possibly near spring in Qac on south side of Bennett Creek in Durst Mountain quadrangle (SW1/4 SE1/4 section 26, T. 6N., R. 2E.).

QUATERNARY AND TERTIARY

QTa, QTay, QTao

High-level alluvium (lower Pleistocene and/or Pliocene) - Gravel, sand, silt, and clay above other stream-terrace and alluvial-fan deposits; typically more bouldery than lower alluvium (including units Qafoe and Qaoe); at least locally gravel-armored and poorly sorted; divided into younger (y) and older (o) based on relative height of adjacent deposits (see table 1); present about 160 to 300+ feet (50-90+ m) above Cottonwood Creek; as much as 800 feet (240 m) above the Weber River in Morgan Valley; located above Qaoe, so older than 730 ka; estimate 30 to 70 feet (9-20 m) thick, based on thicknesses in Morgan Valley (Durst Mountain, Snow Basin, Morgan, and Peterson quadrangles).

QTaf High-level alluvial-fan deposits (lower Pleistocene and/or Pliocene) - Gravel, sand, silt, and clay above other stream-terrace and alluvial-fan deposits (including QTa); typically more bouldery than alluvium lower than QTay and QTao (including units Qafoe and Qaoe); at least locally gravel-armored and poorly sorted; located above QTao and in this quadrangle about 1000 feet (300 m) above Cottonwood Creek; estimate 30 to 100 feet (9-30 m) thick. Upper surfaces of these high-level deposits (with QTao) in the Durst Mountain, Peterson, and Snow Basin quadrangles appear to be the Weber Valley surface of Eardley (1944); however, high-level alluvial fans (QTaf) extend to mountain front at elevations of about 6800 to 7200 feet (2070-2195 m), rather than to the mountain ridgelines as suggested by Eardley (1944).

TERTIARY

Ts Tertiary strata, undivided - Used where multiple Tertiary map units are in landslide blocks, Qms(Ts), and for mostly concealed outcrops with characteristics of Tcg, Tcw,

Tca, and Thv west of Elk Mountain block.

Thv Fanglomerate of Huntsville (Pliocene? and Miocene) - Typically dark-weathering, poorly to moderately consolidated, pebble to boulder gravel in brown to reddish-brown silt and sand that typically erodes to gravel-covered slopes with stone stripes; gravel and matrix reflects source of Wasatch Formation as well as Paleozoic and Precambrian rocks exposed in Durst-Elk Mountain block; in contrast, where fanglomerate is next to Tintic Quartzite (Ct) exposures on west flank of mountain block and in graben, clasts are angular to subangular Tintic, with less red matrix; unconformably overlies conglomeratic strata, Tcy south of Cottonwood Canyon with slight angular discordance and Tcy? near Bally Watts Creek (south of Sheep Herd Creek and north of Elk Mountain) with angular unconformity and change to larger clast quartzite conglomerate; overlies Tcw north of Sheep Herd Creek (north end of Elk Mountains block) with no recognizable change in dip and vague change to more Wasatch-Formation-looking clasts and matrix; may include Tcy or Tct equivalent strata in graben in Durst Mountain but lack of exposures precludes identification; estimate 40 to 1000 feet (12-300 m) thick on west flank of Durst Mountain and up to about 500 feet (150 m) thick on sides of Elk Mountain; thickness on Durst Mountain not known but several hundred feet of reddish strata exposed in graben; may be only up to about 500 feet (150 m) thick on west flank of Durst Mountain if repeated by fault or folded into syncline (see lineament on map); queried where identification uncertain; locally includes landslides, slumps, and flows that are too small to show at map scale, especially on Durst Mountain block. May be unit east of lineament up Bally Watts Creek or could be Tcy, Tcw, Tca, and/or Tcg, so Ts used on map.
In Durst Mountain quadrangle west of Durst Mountain block, fanglomerate typically dips about 10° to 15° east into mountain and underlies prominent gently (<3°) northwest-dipping QTaf; to south in Morgan quadrangle folded into syncline with Tcy just west of faults bounding Durst Mountain, with typically flat-lying to gently (<5°) dipping beds on both limbs and locally steeper dips (~10-30°) on east limb of syncline.
Named Huntsville fanglomerate but not mapped by Eardley (1955) and his Huntsville unit likely equal to QTc unit of Mullens and Laraway (1973); previously reported to be 0 to 400 or 1000 feet (0-120 or 300 m) thick (Lofgren, 1955; Schick, 1955; Mullens and Laraway, 1973); Mullens and Laraway (1973) descriptions of quartzite clasts are misleading; deposits included in Schick (1955) and Coody (1957) Huntsville fanglomerate and unit QTc of Mullens and Laraway (1973) have several ages and origins, so are here divided into units Qcg, Qng, Thv, and Tcy, as well as Tcw, Tct, Tca, and Tcg, and the fanglomerate of Huntsville is here redefined and restricted.

Tcy Younger unnamed Tertiary conglomeratic rocks (Miocene?) - Rounded, pebble- to boulder-sized, quartzite-clast conglomerate with gray, tan, or reddish matrix and some mudstone, siltstone, and sandstone; since lithologically like unit Tcg, Tcy-Tcg contact based on change in dip across angular unconformity (5-10° vs >10° in Morgan quadrangle) and more regular bedding in Tcy; locally erodes to gravel-covered slopes with stone stripes; Tcy-Tcg contact is easily visible angular unconformity at Durst

Mountain-Morgan quadrangle boundary but becomes less distinct to north (Tcy queried on map); in Morgan quadrangle, Tcy has gentle bedding dips to the east with syncline axis visible, though east limb is concealed (folded with Thv); estimate 200 to 400 feet (60-120 m) thick in Durst Mountain quadrangle; locally includes landslides, slumps, and flows that are too small to show at map scale.

In Durst Mountain quadrangle, Tcy is not present north of Sheep Herd Creek (Thv "rests" on Tcw), while just south of Sheep Herd Creek, lower dips indicate Tcy might be present below Thv (queried on map); to the south Tcy-equivalent strata (above Tcy marker beds on map) might be present west of Bally Watts Creek in Tcw (based on marker bed that connects across lineament to Tcy? lower contact) and west of Elk Mountain in Tca and Tct (based on marker bed at possible angular unconformity); might be same age as Salt Lake Formation (Pliocene and upper Miocene); previously included in Huntsville fanglomerate (see Thv); mapped Tcy-Thv contact (lithologic change and unconformity) is more distinct than Tcy-Tcg contact (unconformity with no consistent lithologic change).

Tcg, Tcw, Tct, Tca

Unnamed Tertiary conglomeratic rocks (Oligocene?) - Characterized by rounded, cobble- to boulder-sized, quartzite-clast conglomerate with pebbles and less than 10 to more than 50 percent gray, tan, or reddish matrix; interbedded with tan, gray, and reddish-brown pebble-bearing mudstone to sandstone and some claystone (altered tuff); most beds poorly indurated and poorly exposed; some non-conglomeratic beds in Tcg look like the gray upper Norwood Formation (Tn) and are locally tuffaceous (note white marker bed on map just below Tcw); mudstone likely constitutes the matrix of the conglomeratic beds; some Tcg pebble beds have carbonate and chert (like Norwood) and lesser quartzite clasts; Tcg conglomerates include rare altered tuff clasts from Norwood Formation (Tn); locally erodes to gravel-covered slopes with stone stripes; locally includes landslides, slumps, and flows that are too small to show at map scale. Subdivided into Tct, Tca, and Tcw lithosomes near Elk Mountain, based on clast characteristics (t=Tintic, a=angular, and w=Wasatch). These conglomeratic strata (Tcg, Tcw, Tct, Tca) are an estimated 500 feet (150 m) thick in aggregate and thicken northward in Durst Mountain quadrangle to possibly 3000 feet (900 m) thick, though faulting may make this estimate too large; previously included in Huntsville fanglomerate (see Thv).

Subunit Tcw has mostly recycled Wasatch Formation clasts (quartzite and carbonate) with a distinct reddish patina; it looks like the fanglomerate of Huntsville (Thv), but typically Tcw matrix is less red than Thv and lacks red sandstone/siltstone clasts of Thv. Tcw overlies Tcg near Bally Watts Creek and appears to grade laterally into Tcg just north of Cottonwood Canyon.

Subunits Tct and Tca appear restricted to a graben on the west side of Elk Mountain near exposures of Tintic Quartzite. Tct has mostly angular clasts of Tintic Quartzite and the clasts were likely derived from nearby faulted Tintic. Tct is mapped as two tongues, the lower in Tcw, and the upper above and likely into Tca (see correlation chart). Tca is cemented and has angular and rounded carbonate and angular Tintic clasts; it overlies Tcw and it appears to be the more distal (less angular quartzite) equivalent of Tct.

In Durst Mountain quadrangle, north of Cottonwood Creek, Tcg contact with Norwood Formation (Tn) based on resistant quartzite cobble/boulder conglomerate bed at least 30 feet (9 m) thick; this resistant bed is overlain by thinner non-resistant quartzite-clast beds and a relatively thick interval that looks like interbedded upper Norwood Formation (Tn) and reddish-brown strata. Because this resistant bed and overlying quartzite-clast beds grade northward into Norwood sandstone and pebble beds, the contact is also placed at the bottom of the lowest quartzite cobble bed at least 6 feet (2 m) thick and is partly based on regular bedding and reddish-brown strata in Tcg; the lack of angular unconformity at any of these quartzite-clast beds means the Norwood and this unit (Tcg) are interbedded; with the exception of the resistant (lowest) bed, cobble/boulder beds become thicker and clasts becoming bigger higher in Tcg; quartzite clasts are recycled Wasatch Formation clasts; Tcg is present on west side of Durst Mountain block and is faulted or, with Thv, folded into syncline (lineament on map); north of Cottonwood Canyon Tcg is overlain by Tcw, Tct, and Tca lithosomes with no apparent unconformity (unconformity may be within these lithosomes) and Tcy with angular unconformity.

Tn Norwood Formation (lower Oligocene and upper Eocene) - Typically light-gray to light-brown, altered tuff (claystone), tuffaceous siltstone, sandstone, and conglomerate; locally colored light shades of red and green; variably calcareous cement and zeolitization, but less common than to northwest in Snow Basin quadrangle; lacks extensive unaltered tuff present to south in Morgan quadrangle; upper Norwood Formation, as exposed on west margin of Durst Mountain quadrangle, and in northern Morgan quadrangle, is gray, granule to small pebble conglomerate, with chert and carbonate clasts, as well as claystone and fine- to coarse-grained sandstone; near Wasatch Formation (Tw) knob on Snow Basin-Durst Mountain quadrangle boundary there is much quartzite gravel in Norwood that disappears just north of the knob; also upper Norwood contains tuffaceous beds interbedded with pebble and quartzite-clast conglomerate on west margin of Durst Mountain quadrangle; these variations make it difficult to map Tcg-Tn contact (see also Tcg); from outcrop pattern, dip, and topography, Norwood is at least 7000 feet (2100 m) thick to west in Snow Basin quadrangle; thins to the south so about 5000 feet (1500 m) thick north of Morgan; about 1500-foot (460 m) thickness exposed east of East Canyon Creek in type area in Porterville quadrangle (not 800+ m inferred by Bryant and others (1989, p. K6); locally includes landslides, slumps, and flows that are too small to show at map scale.

Norwood Formation generally considered younger than the Fowkes Formation, but not well dated due to alteration. Corrected Norwood K-Ar ages are 38.4 Ma (sanidine) from Norwood type area (Evernden and others, 1964) and 39.3 Ma (biotite) from farther south in East Canyon (Mann, 1974), while Fowkes $^{40}Ar/^{39}Ar$ ages are 40.41 Ma and 38.78 Ma on biotite and hornblende, respectively, from the Castle Rock quadrangle to east near Wyoming (King, unpublished); basal part of similar unit to north in western Cache Valley ("resting" on Wasatch and less than 600 feet thick) dated at 44.2 $\pm$ 1.7 Ma and 48.6 $\pm$ 1.3 Ma K-Ar on hornblende and biotite, respectively, with the latter date suspect (Smith, 1997; King, unpublished).

Unit referred to as Norwood Formation rather than using Norwood Tuff name of previous workers (see Eardley, 1944), because lithologies vary away from type area and the type area includes only part of formation; in southern Morgan quadrangle near type area, has much unaltered tuff, cut-and-fill structures (fluvial), volcanic-clast conglomerate, and local limestone and silica-cemented rocks.

Tw Wasatch Formation (Eocene and uppermost Paleocene) - Typically red to reddish-brown sandstone, siltstone, mudstone, and conglomerate; clasts typically rounded and from Precambrian and Paleozoic sedimentary rocks; lighter shades of red, yellow/tan, and light gray more common in uppermost Wasatch on east margin of Durst Mountain quadrangle and near Morgan; basal conglomerate contains locally derived clasts where contact with underlying rocks is exposed and is less likely to be red; Wasatch knobs north of Cottonwood Creek are reddish to light-gray to brownish-gray, variably cemented conglomeratic rocks; queried Wasatch is reddish strata that might be uneroded remnants on the southeast part of Durst Mountain, and in the southwest part of the quadrangle might be an exotic block in Thv or Wasatch subcrop like that north of Cottonwood Creek; Mullens (1971, p. 18) reported scattered beds up to 15 feet (5 m) thick of pale-red silty and gray algal limestone south of Morgan and similar beds may be present in eastern Durst Mountain quadrangle where field examinations were limited; about 1000 foot (300 m) exposed thickness in northeast Durst Mountain quadrangle; thickness varies locally due to considerable relief on basal erosional surface; total thickness increases up to about 4500 feet (1370 m) to south in Porterville quadrangle (Mann, 1974) and east near Henefer (Coogan, 2004b); locally includes landslides, slumps, and flows that are too small to show at map scale.
North of Cottonwood Creek on west margin of map area (mostly to the west in the Snow Basin quadrangle), Wasatch, possibly along with Norwood strata, is apparently draped over a knob of highly fractured Cambrian Tintic Quartzite. This knob is either an exotic block emplaced before or during Wasatch deposition or the knob is fault zone rocks. The knob may be an exposure of the Cretaceous Ogden thrust fault zone or, more likely, the Tertiary (post-Wasatch) normal fault zone on the west flank of Durst Mountain, about 2 to 3 miles (3-5 km) to the southeast.

TERTIARY AND CRETACEOUS

TK Wasatch Formation and/or Hams Fork Member of Evanston Formation - Only used where both map units are in landslide blocks, Qms(TK), and for an isolated, small, thin exposure of conglomeratic strata on northeast flank of Elk Mountain.

CRETACEOUS

Keh Hams Fork Member of Evanston Formation (Upper Cretaceous-Maastrichtian/Campanian) - Light-gray, brownish-gray, and tan sandstone, conglomeratic sandstone, and quartzite- and chert-pebble conglomerate, and variegated gray, greenish-gray, and red mudstone; lacks carbonaceous shale and coal that is present in upper part in Lost Creek area (see Coogan, 2004b); member coarsens downward to gray and brownish-

gray, cobble conglomerate containing distinctive Proterozoic quartzite clasts; estimated thickness in this quadrangle 0 to 1000 feet (0-300 m); unconformably overlies Mesozoic and Paleozoic rocks; to east, this unit thickens from 300 feet (90 m) at Echo Canyon to 1200 feet (365 m) to north near Lost Creek Dam (Coogan, 2004b) and then thins to north to less than 450 (140 m) in Horse Ridge quadrangle (Coogan, 2006).

JURASSIC

Jn Nugget Sandstone (Lower Jurassic) - Pale-grayish-orange, pinkish, and locally white, well-cemented, cross-bedded, quartz sandstone; incompletely exposed near Quarry Hollow; about 1100 to 1500 feet (335-460 m) thick to east and southeast at Toone Canyon, Lost Creek Dam quadrangle (Madsen, 1959; Coogan, 2004b) and near Devils Slide (Eardley, 1944); thickness near Devils Slide (estimated by King from outcrop pattern, dip, and topography) as about 1250 to 1360 feet (380-415 m).

TRIASSIC (Thickness estimates in Devils Slide quadrangle are by King from outcrop pattern, dip, and topography)

TRa Ankareh Formation, Higham Grit, and Thaynes Formation, undivided (Triassic) - Upper Ankareh member (or Wood Shale Tongue) is bright-orange-red shale, siltstone, and sandstone and is exposed near Quarry Hollow; lower units (Higham Grit, two members of Thaynes, and lower member of Ankareh) likely not exposed in Durst Mountain quadrangle; upper Ankareh member reportedly 515 feet (155 m) thick near Devils Slide (Schick, 1955), but an estimated 600 to 680 feet (185-210 m) thick in Devils Slide quadrangle. Undivided TRa map unit reportedly about 1100 feet (335 m) thick near Devils Slide (Eardley, 1944; Schick, 1955) and about 1150 feet (350 m) thick in Lost Creek drainage (Coogan, 2004a).

To east in Lost Creek drainage the lower units are about 200 feet (60 m) thick and in descending order are: gray and greenish-gray, quartz-granule sandstone (Higham Grit); gray-green lithic-pebble conglomerate (Timothy Sandstone Member of Thaynes); limestone (Portneauf Limestone Member of Thaynes); and purple and brownish-red shale, siltstone, and sandstone (Lanes Tongue of Ankareh) (Coogan, 2004a). Closer to southeast at Devils Slide, units are gritty to conglomeratic sandstone 30 to 43 feet (15 m) thick (Gartra Grit?) and lower brownish red unit (Mahogany Member) like the Lanes that is reportedly 465 to 920 feet (140-280 m) thick (Schick, 1955; Smith, 1969), but here estimated as 600 to 725 feet (185-220 m) thick in Devils Slide quadrangle.

TRt Thaynes Formation (Lower Triassic) - Regionally comprised by brownish-gray and gray, calcareous siltstone and limestone in upper and lower part, separated by resistant, gray, limestone ridge (see Kummel, 1954); several hundred feet exposed near Bennett Creek but neither top nor bottom contacts exposed, so upper tongue of Dinwoody may or may not be present; regionally 1835 feet (560 m) thick in Lost Creek drainage (supercedes Coogan, 2004a), with the same estimated thickness in the Devils Slide quadrangle, though 2200 feet (670 m) thickness reportedly exposed near Devils Slide (Eardley, 1944).

TRw Woodside Formation (Lower Triassic) - Dark-red, sandy shale and siltstone, with some sandstone; basal part exposed near Sheep Herd Creek; about 500 foot (150 m) thickness estimated in the Devils Slide quadrangle and 990 feet (300 m) reported by Smith (1969), with about 800 feet (245 m) thickness shown by Mullens and Laraway (1964, cross section).

TRd Dinwoody Formation (Lower Triassic) - Greenish-gray and tan, calcareous siltstone and silty limestone; uncertain thickness exposed near Sheep Herd Creek, but seems to be about the 500 foot (150 m) thickness shown by Mullens and Laraway (1964, cross section) in Devils Slide quadrangle; about 300 feet (90 m) thickness estimated and 290 feet (90 m) reported by Smith (1969) in the Devils Slide quadrangle.

PERMIAN

Pp Park City and Phosphoria Formations, undivided - Not subdivided near Bennett Creek; Eardley identified these brecciated rocks as Weber quartzite (Coody, 1957); stratigraphic offset on the adjacent Bennett Creek thrust is in excess of 4000 feet (1200 m). Total thickness in Hardy Hollow, Durst Mountain quadrangle 675 feet (205 m) (Schell and Moore, 1970); 857 feet (260 m) thick to southeast near Devils Slide, but lower two units may be faulted (Cheney and others, 1953; Cheney, 1957); subdivided between Sheep Herd Creek and Hardy Hollow into members.

Ppf Franson Member of Park City and Rex Chert Member of Phosphoria - Interbedded gray to pinkish-gray to dark-gray, vuggy, cherty limestone, with lesser gray shale and calcareous sandstone, and dark-gray and black, bedded chert; 43 feet (15 m) thickness of Rex Chert(?) Member of Phosphoria and 241 feet (75 m) thickness of Franson near Hardy Hollow, with 242 feet (75 m) thickness of combined Franson/Rex near Devils Slide.

Ppm Meade Peak Phosphatic Shale Member of Phosphoria - Gray limestone, dark-gray to black, phosphatic siltstone and shale, and gray, calcareous sandstone; typically less resistant than adjacent members; 171 feet (50 m) thick near Hardy Hollow, with 303 feet (90 m) near Devils Slide.

Ppg Grandeur Member of Park City - Light-gray, thick-bedded, dolomitic sandstone with gray chert nodules; 220 feet (65 m) thick near Hardy Hollow with 312 feet (95 m) near Devils Slide.

PERMIAN AND PENNSYLVANIAN

PIPw Weber Sandstone (Lower Permian and Pennsylvanian) - Gray, indurated, quartzose sandstone with dolomite and siltstone in lower part; 2500 to 3123 feet (760-952 m) thick near Morgan (Eardley, 1944; Bissell and Childs, 1958 [2260 feet Weber + 381 feet "Park City"]; Mullens and Laraway, 1973)(see also Williams, 1943). Divided into upper (Pwu) and lower (PIPwl) parts north of Hardy Hollow in Durst Mountain quadrangle, where about 400 feet (120 m) of each unit is exposed, with base of lower unit not exposed; because these exposures are thin, disconformity in unit (see Welsh and Bissell, 1979, p. Y22) is likely not at this contact; relation of limestone marker (PIPwls) Coogan mapped on Durst Mountain to these units and the disconformity is not known, the marker appears

to be in the upper unit that King (unpublished) mapped to the south in the Morgan quadrangle; both units mapped north of Hardy Hollow also appear to be in the upper unit of King (PIPwu this report).
Where possible in the Durst Mountain quadrangle, and to south in Morgan quadrangle, King divided Weber into IPwl (lower) with distinct regular bedding and PIPwu (upper) with less distinct bedding; IPwl may be units 1-3 of Eardley (1944); pre *Fusulina* strata of Bissell and Childs (1958); or Desmoinesian strata of Welsh and Bissell (1979, p. Y23); the disconformity may or may not be at King's subunit contact.

PENNSYLVANIAN

IPm Morgan Formation (Pennsylvanian) - Sandstone, siltstone and limestone that grades northward into lower part of Weber Sandstone, "pinching" out to north in southern Durst Mountain quadrangle; thrust faulted "into" Weber rather than intertongued; queried on leading edge of west-directed back thrust where carbonate-bearing strata identified as Morgan might be in the lower Weber; 0 to 1000 feet (0-300 m) thick in Morgan area (Eardley, 1944; Bissell and Childs, 1958; Mullens and Laraway, 1973) (see also Williams, 1943).

IPr Round Valley Limestone (Pennsylvanian and possibly Mississippian) - Mostly light-gray, fine-grained limestone with regular bedding visible on aerial photographs; about 375 to 400 feet (115-120 m) thick near Morgan (Crittenden, 1959; Mullens and Laraway, 1973); Carey (1973) reported a thickness of 335 feet (102 m) at the type section east of Morgan, while Sadlick (1955) reported 394 feet (120 m).

MISSISSIPPIAN (Thickness estimates by King from outcrop pattern, dip, and topography on Durst Mountain in the Durst Mountain quadrangle)
Doughnut Formation (Upper Mississippian)

Mdu Upper member - Limestone and siltstone; about 290 and 334 feet (90 and 100 m) thick near Morgan (Mullens and Laraway, 1973; and Crittenden, 1959, respectively), and about 300 feet (90 m) estimated in Durst Mountain quadrangle. Nohara (1966) called this the upper Great Blue Limestone and reported it is about 400 feet (120 m) thick, with upper contact concealed.

Mdl Lower, shale member - Poorly exposed siltstone, black shale, and limestone; typically less resistant than adjacent map units; about 100 to 200 feet (30-60 m) thick near Morgan (Mullens and Laraway, 1973; Crittenden, 1959), and about 200 feet (60 m) estimated in Durst Mountain quadrangle. Nohara (1966) called this the middle shale in Great Blue Limestone and reported about 100 feet (30 m) thickness.

Humbug Formation (Upper Mississippian) - About 600 feet (180 m) of tan- to reddish-weathering, quartzose sandstone and interbedded limestone (Crittenden, 1959); estimate total thickness as 700 feet (215 m); contact within Humbug placed so lower member is less resistant than upper member.

Mhu Upper member - Limestone with sandstone beds near base; estimate thickness as 400 feet

(120 m); reportedly about 300 to 350 feet (90-105 m) thick in Morgan quadrangle (Mullens and Laraway, 1973). Lower Great Blue Limestone of Nohara (1966), about 330 or 400 feet thick.

Mhl Lower member - Sandstone with limestone and dolomite interbeds; estimate thickness as 300 feet (90 m); reportedly about 400 to 600 feet (120-185 m) thick in Morgan quadrangle (Mullens and Laraway, 1973).

Mde Deseret Limestone (Mississippian) - Limestone, dolomite and sandstone, with dark, non-resistant, phosphatic shale at base (Delle Phosphatic Shale Member, locally mapped as Mdd); about 500 feet (150 m) thick in Morgan quadrangle (Mullens and Laraway, 1973) and estimated on Durst Mountain.

Ml Lodgepole Limestone (Lower Mississippian) - Gray, fossiliferous limestone, locally cherty; estimate thickness as 650 feet (200 m); reported thicknesses about 650, 755, and 800 feet (200, 230, 245 m) (Eardley, 1944, near Morgan; Williams, 1943, Durst Mountain; Mullens and Laraway, 1973, near Morgan, respectively); called Gardison Limestone to west in Ogden Canyon.

DEVONIAN

Beirdneau, Hyrum, and Water Canyon names are from Willard thrust sheet and may not be appropriate for strata deposited in shallower water on the continental shelf, and in what is now the Crawford thrust sheet. Typically on the Crawford thrust sheet to the north and east Beirdneau=Three Forks and Hyrum=Jefferson with no Water Canyon equivalent (see Benson, 1966; Johnson and others, 1991). We chose to retain the Willard thrust sheet names because they have been used previously (Eliason, 1969; Williams, 1971), previous work on the Durst Mountain Devonian and upper Cambrian strata is confusing (see previous references as well as Eardley, 1944; Brooks and Andrichuk, 1953; Brooks, 1954; Schick, 1955; Brooks, 1959; Mullens and Laraway, 1973), and the distinct light-colored dolomite at the top of our Water Canyon unit is typical of Water Canyon strata on the Willard thrust sheet. Thickness estimates by King from outcrop pattern, dip, and topography south of Cottonwood Canyon in the Durst Mountain quadrangle. Devonian age subdivisions are not noted due to unit name uncertainty.

Db Beirdneau Sandstone - Reddish-tan to tan to yellowish-gray, calcareous sandstone, siltstone, some sandy dolomite and limestone, and lesser intraformational conglomerate; less resistant than adjacent map units; estimate thickness as 200 feet (60 m); field thickness on Durst Mountain of about 300 feet (90 m); reported thicknesses near Morgan about 185 and 230 feet (55 & 70 m) (Eliason, 1969; Three Forks of Mullens and Laraway, 1973, respectively). A bed of brownish-gray dolomite, resembling Hyrum Dolomite, is present in middle part of Beirdneau to northeast on the Crawford thrust sheet in Horse Ridge quadrangle (Coogan, 2006), and a thin (~10 feet [3 m]) bed seems to be present on Durst Mountain as well, though color is slightly different.

Dh Hyrum Dolomite - Dark- to medium-brownish-gray and gray, medium-bedded, coarsely crystalline dolomite; weathers distinctive dark-chocolate brown; more resistant at top and bottom with center of less resistant beds that grade laterally into reddish, dirty carbonate like the Beirdneau Sandstone; this gradation created problems in mapping Db-Dh contacts and faults cutting these units, and in estimating thicknesses; estimate thickness as 250 to 450 feet (75-140 m); reported thickness, about 136 feet (40 m) (Eliason, 1969), is too thin relative to adjacent units.

Dwc Water Canyon Formation - Interbedded calcareous sandstone and sandy dolomite and limestone with sandstone below carbonate and a distinctive very light-gray, yellow-weathering dolomite at top; estimate 200 feet (60 m) thick (see also Eardley, 1944, Cambrian units 9-12, 155 feet [47 m]); about 100 to 150 feet (30-45 m) thick to northeast on leading edge of Willard thrust sheet (Coogan, 2006).

SILURIAN and ORDOVICIAN – Missing in area, along with all or most(?) of St. Charles Formation equivalent strata (uppermost Cambrian), due to thinning over Tooele arch (Hintze, 1959; Rigby, 1959).

CAMBRIAN (Thickness estimates by King from outcrop pattern, dip, and topography south of Cottonwood Canyon in the Durst Mountain quadrangle.)

Cn Nounan Formation (Upper and Middle Cambrian) - Medium-dark-gray, thick-bedded dolomite and limestone; estimate 350 to 400 feet (105-120 m) thick (see also Eardley, 1944, Cambrian units 6-8, 315 feet [95 m]). Bloomington Formation not present on Durst Mountain or Elk Mountain.

Cm Maxfield Limestone (Middle Cambrian) - Limestone and calcareous siltstone; estimate thickness as 300 feet (90 m); at least 280 foot (80 m) thickness inferred from Eardley (1944, Cambrian units 3-5), that is, at least to top of limestone edgewise (flat-pebble) conglomerate; Cambrian limestone of Mullens and Laraway (1973) includes Maxfield and upper two members of Ophir Formation.

Ophir Formation (Middle Cambrian) - Estimate at least 380 to 725 feet (115-220 m) thick in Durst Mountain and Morgan quadrangles; about 300 to 660 feet (90-200 m) thick in Ogden Canyon west of map area; Ophir of Eardley (1944) and Mullens and Laraway (1973) is lower argillite member.

Cou Upper argillite member - Dark-brown-gray to olive-gray argillite with intercalated medium-gray limestone beds; slope-forming and rarely exposed; thickness highly variable, about 425 feet (130 m) thickness inferred from Eardley (1944, Cambrian unit 2), but likely structurally doubled where he measured; actual thickness here estimated as 180 feet (55 m).

Com Middle limestone member - Thin- to medium-bedded, light- to medium-gray, ledge-forming, micritic limestone with local orange-gray silty ribbons; generally highly deformed, apparent thickness 60 to 165 feet (18-50 m); actual thickness about 100 feet

(30 m) (this report; Cambrian unit 1 of Eardley, 1944).

Col Lower argillite member - Dark-brown, orange-brown, and olive-gray argillite, silty argillite, and siltstone with rare gray limestone beds; slope forming; interbedded siltstone and sandstone at base grades downward into Tintic Quartzite; thickness highly variable, about 100 to 400 feet (30-120 m) thick, due to structural deformation; actual thickness here estimated as 200 feet (60 m), the same as Eardley (1944) reported.

Ct Tintic Quartzite (Middle and(?) Lower Cambrian) - Tan, very-well-cemented quartzite, conglomeratic in lower half with Precambrian quartzite pebbles and cobbles; basal 50 to 100 feet (15-30 m) is arkosic conglomerate of Farmington Canyon Complex material; about 800 to 1500 feet (245-460 m) thick (Mullens and Laraway, 1973); Eardley (1944) reported about 1000 foot (300 m) thickness at Durst Mountain. Highly fractured knob of Tintic exposed on west margin of Durst Mountain quadrangle.

PROTEROZOIC

Xf Farmington Canyon Complex (lower Proterozoic) - Micaceous schistose and gneissic crystalline rocks with small bodies of amphibolite and pegmatite, variously called dikes and pods; locally includes landslides, slumps, and flows that are too small to show at map scale; Barnett and others (1993) reported the various isotopic ages of the complex in the Wasatch Range and concluded it is Early Proterozoic (about 1700 Ma) in age.

Xfpg Farmington Canyon Complex, pegmatite (lower Proterozoic) - A large conspicuous pegmatite on the south side of Cottonwood Creek Canyon and poorly exposed pegmatite along bladed road near graben in quadrangle are mapped separately (sections 14 and 26, T. 5N., R. 2E., respectively).

WILLARD THRUST SHEET

PROTEROZOIC

Zm Mutual Formation (upper Proterozoic) - Purplish quartzite, locally arkosic; 435 to 1200 feet (135-365 m) thick in Browns Hole (Crittenden and others, 1971; Crittenden, 1972) adjacent to map area.

Zi Inkom Formation (upper Proterozoic) - Argillite to psammite (meta-sandstone over meta-siltstone) with basal meta-tuff lenses; 360 to 450 feet (110-140 m) thick north of map area (Crittenden and others, 1971; Crittenden, 1972).

Zcc Caddy Canyon Quartzite (upper Proterozoic) - Mostly vitreous, almost white quartzite; 1500 to 2000 feet (460-610 m) thick just north of the map area (Crittenden and others, 1971; Crittenden, 1972).

Zkc Kelley Canyon Formation (upper Proterozoic) - Argillite to phyllite, with rare meta-carbonate; grades into overlying Caddy Canyon quartzite with increasing quartzite near Huntsville; 2000 feet (610 m) thick just north of map area (Crittenden and others, 1971).

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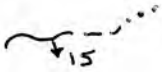
MAP SYMBOLS



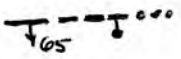
Contact, dashed where approximately located or gradational, dotted where concealed; arrow and number indicate photogrammetric dip on unconformable Keh lower contact.

Marker beds (extrapolated where concealed)
unlabeled in Thv - to show unconformity with QTaf south of Cottonwood Creek
unlabeled in Tcy - to show unconformity in southwest corner of map area
unlabeled in Tct and Tca - to show possible lateral gradation of subunits

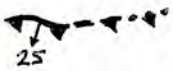
Tcy? - for possible equivalent to unconformable basal Tcy contact

wm, wm?, for white, altered tuff bed high in Tcg - to show Norwood Formation interbedded with Tcg
unlabeled in Tcg and Tcw - to show possible lateral gradation of subunits
unlabeled in Db - to show offset across fault

Fault, dashed where approximately located, dotted where concealed, sense of movement unknown



Normal fault, bar and ball on downthrown side, dashed where approximately located, dotted where concealed; arrow and number indicate photogrammetric dip on fault



Thrust fault, teeth on upper plate, dashed where approximately located, dotted where concealed; arrow and number indicate photogrammetric dip on fault

Lineament (fold axis or fault)

Anticline axis, dashed where approximately located, arrow shows plunge, dotted where concealed

Syncline axis, dashed where approximately located (very approximate for broad syncline in units Tw and Keh), arrow shows plunge, dotted where concealed

Monocline (flexure)

Overturned monocline, approximately located

Lake Bonneville shoreline (not dotted where partially concealed)

B Bonneville (about 5180 feet [1579 m])

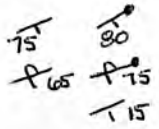
x transgressional

Mass-movement scarp

Topographic scarp (likely fluvial; not fault or shoreline)

Moraine crest or ice-carved bedrock ridge

Strike and Dip of bedding



Upright (top known from bedding indicators on right)
Overturned (top known from bedding indicators on right)
Photogrammetric, upright

65 Foliation

70 Cleavage

25 Lineation, with plunge angle

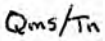
sinkhole

spring

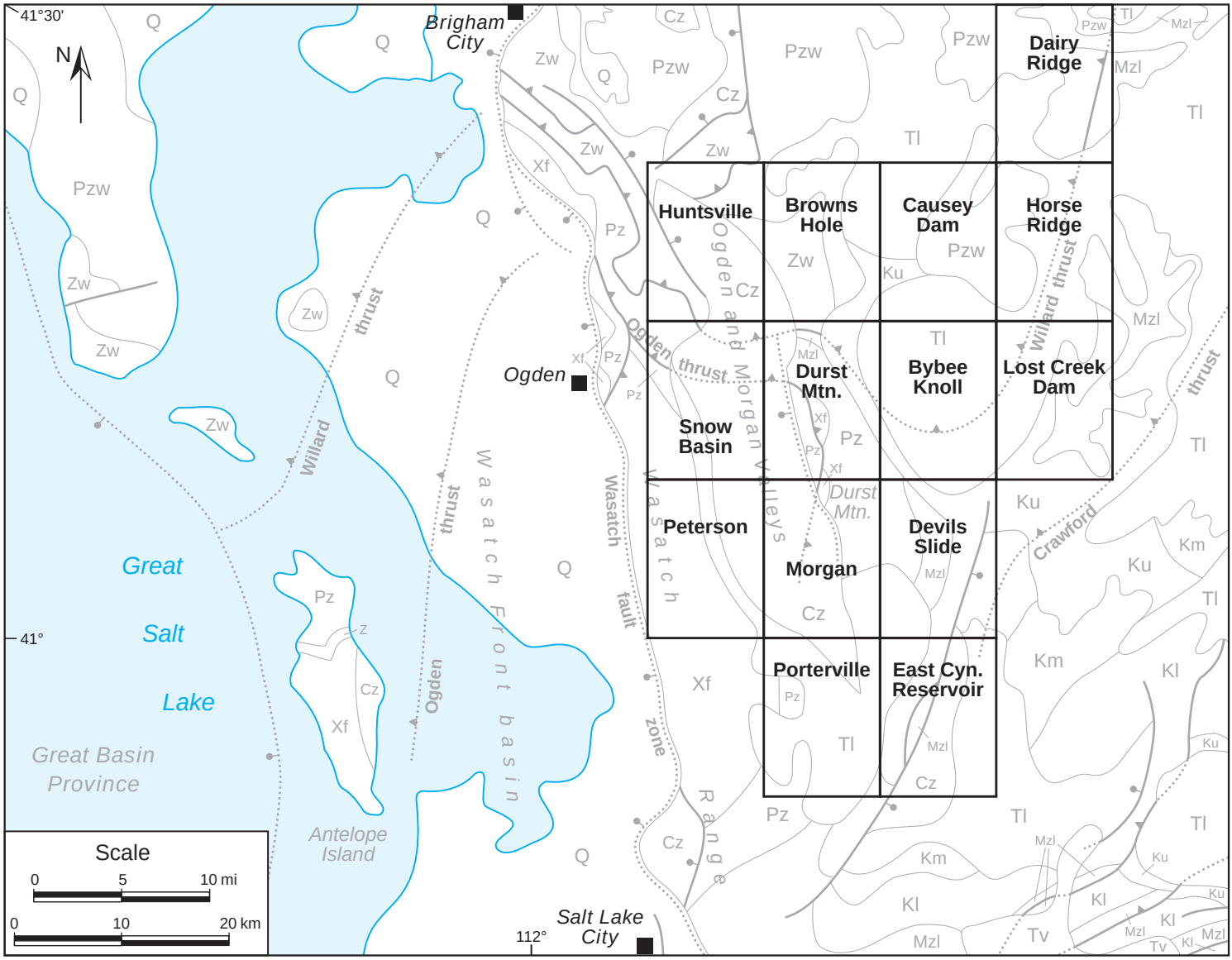
prospect

quarry

Thin Quaternary unit over another unit, for example Ql/Tcg



Landslide with nearly intact rotated blocks of unit in parentheses, for example Qms(Tn), Qms(Ts), and Qms(Xf); queried (Qms?, Qmso?) where blocks may be in place.



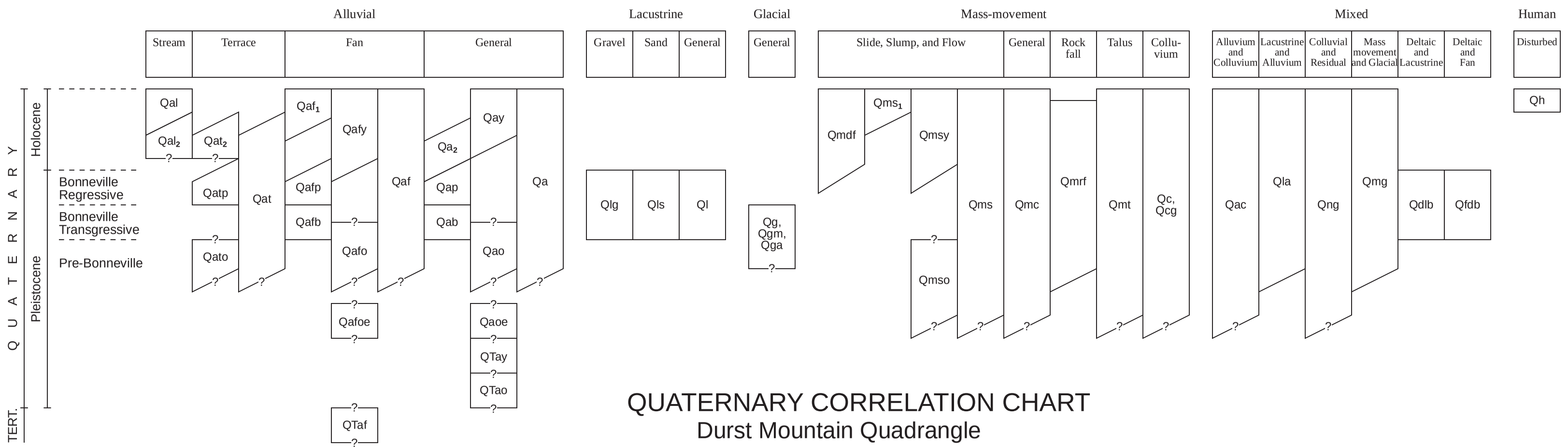
Q	Quaternary deposits
Cz	Cenozoic basin fill
Tl	Tertiary, lower
Tv	Tertiary volcanics
Ku	Cretaceous, upper
Km	Cretaceous, middle
Kl	Cretaceous, lower
Mzl	Mesozoic, lower
Pz	Paleozoic
Pzw	Paleozoic, Willard thrust sheet
Zw	Late Proterozoic, Willard thrust sheet
Xf	Farmington Canyon Complex

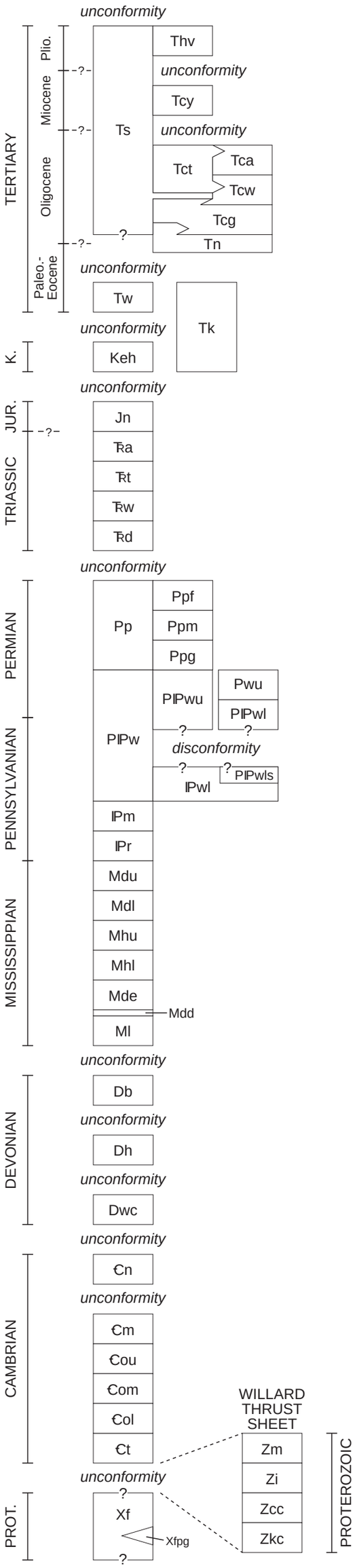
Table 1. Heights of alluvial deposits above adjacent active drainages in the Durst Mountain quadrangle. Heights are similar in Weber River Valley in adjacent Morgan, Peterson, and Snow Basin quadrangles. Older ages (>150ka) from information in Sullivan and others (1988) and Sullivan and Nelson (1992).

Unit(s)	Feet (m) above drainage	Age (ka=1000) years	Comments
Qal, Qay, Qafy	at to slightly above	<~10 ka	
Qa2	~15 feet (5 m)	<~13 ka	
Qat2	~20 feet (6 m)		
Qap	15 to 40 feet (5-12 m)		
Qatp	25 to 30 feet (8-9 m)	~13-15 ka	
Qafp	~ 40 to 45 feet (12-14 m)		
Qab	40 to 80 feet (12-24 m)	~15-20 ka	
Qafb	> ~40 feet (>14 m)		
Apparently absent		~130-150 ka	"Bull Lake" glaciation-related deposits
Qao	70 to 120 feet (20-37 m)		
Qato	~100 feet (30 m)		
Qafo	~70 to 110 feet (20-35 m)	300-600 ka	where dated may really be Qafoe
Qaoe?	80 to 100 feet (24-30 m)		correlation uncertain
Qaoe	120 to 200 feet (35-60 m)	>730 ka	where dated may really be QTay
Qafoe	~160 feet (50 m)		
QTay	~160 to 300+ feet (50-90+ m)	>730 ka	
QTao	~320 to 800 feet (100-240 m)	>730 ka	height extremes from outside quadrangle
QTaf	~1000 feet (300 m)	>730 ka	may be entirely Pliocene

QUATERNARY CORRELATION CHART

Durst Mountain Quadrangle





BEDROCK CORRELATION CHART

Durst Mountain Quadrangle

LITHOLOGIC COLUMN
Durst Mountain Quadrangle

AGE	MAP SYMBOL	MAP UNIT	THICKNESS FEET	THICKNESS METERS	OTHER INFORMATION
Q.	Q-various	alluvium, lake beds, mass movements	0-300	0-90	
TERTIARY P.-E.	QT-var.	alluvium, gravel	0-100	0-30	
TERTIARY ?Plio.-M.?	Ts Thv	fanglomerate of Huntsville	40-1000	12-300	
TERTIARY ?Plio.-M.?	Ts Tcy	younger unnamed conglomeratic rocks	200-400	60-120	
TERTIARY ?Plio.-M.?	Ts Tc_	unnamed conglomeratic rocks	500-3000	150-900	Tcg-Tn interbedded
TERTIARY Oligocene?	Ts Tn	Norwood Formation	5000+	1500+	Altered tuff *Protoreodon* 38.4 Ma K-Ar (corrected)
TERTIARY P.-E.	Tw	Wasatch Formation	up to 800-1000	up to 245-300	
K.	Keh	Hams Fork Member of Evanston Formation	0-1000	0-300	
JUR.?	Jn	Nugget Sandstone	1100-1500	335-460	ANGULAR UNCONFORMITY
TRIASSIC	Ra	Wood Shale Tongue of Ankareh Fm	~600	~180	
TRIASSIC	Ra	Higham Grit and Timothy Ss Mbr of Thaynes Fm	35-200	9-60	
TRIASSIC	Ra	Lanes Shale Tongue of Ankareh Fm	~650	~200	Not exposed
TRIASSIC	Rt	Thaynes Formation	1835-2200	560-670	
TRIASSIC	Rw	Woodside Formation	~800	~245	Not exposed
TRIASSIC	Rd	Dinwoody Formation	~300	~90	
PERM.	Pp Ppf	Franson Member of Park City Formation	285	85	UNCONFORMITY Includes Rex Chert
PERM.	Pp Ppm	Meade Peak Member of Phosphoria Fm	170	50	
PERM.	Pp Ppg	Grandeur Member of Park City Formation	220	65	
PENN.	PIPw PIPwu / ? / PIPwl	Weber Sandstone	2500-3000	760-915	Wells Formation? DISCONFORMITY? See correlation chart for other units
PENN.	IPm	Morgan Formation	0-1000	0-300	Absent to north
PENN.	IPr	Round Valley Limestone	400	120	
MISS.	Mdu, Mdl	Doughnut Formation (upper, lower)	500	150	
MISS.	Mhu, Mhl	Humbug Formation (upper, lower)	700	215	
MISS.	Mde	Deseret Limestone	500	150	Delle Phosphatic Member- Mdd
MISS.	Ml	Lodgepole Limestone	650-800	200-245	Fossiliferous
DEV.	Db	Beirdneau Sandstone	200	60	
DEV.	Dh	Hyrum Dolomite	~350	~105	MAJOR UNCONFORMITY
DEV.	Dwc	Water Canyon Formation	200	60	
CAMB.	Cn	Nounan Formation	~350	~105	Cou ~200 ft.
CAMB.	Cm	Maxfield Limestone	300	90	Com 100 ft.
CAMB.	Cou,m,l	Ophir Formation (upper, middle, lower)	380-725	115-220	Col 200 ft.
CAMB.	Ct	Tintic Quartzite	1,000	300	*Skolithus*
EARLY PROTER.	Xf	Farmington Canyon Complex	indeterminable		MAJOR UNCONFORMITY 1,700± Ma Gneiss and schist Xfpg-- pegmatite

WILLARD THRUST SHEET

AGE	MAP SYMBOL	MAP UNIT	THICKNESS FEET	THICKNESS METERS	OTHER INFORMATION
PROTEROZOIC	Zm	Mutual Formation	435-1,200	135-365	Purple to pink Cross-bedded Some feldspar locally
PROTEROZOIC	Zi	Inkom Formation	360-450	110-140	Meta-tuff lenses
PROTEROZOIC	Zcc	Caddy Canyon Quartzite	1,500-2,000	460-610	
PROTEROZOIC	Zkc	Kelley Canyon Formation	2,000	610	Argillitic to phyllitic Base cut by thrust

Diagrams are schematic--- scale approximate